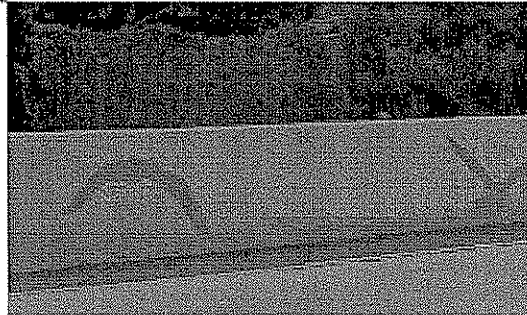


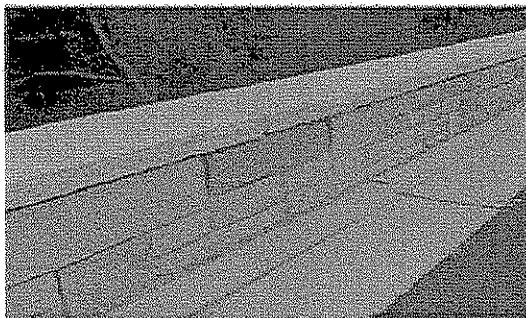


REPORT

June 2002
Edition 1a



CALIFORNIA HIGHWAY BARRIER AESTHETICS



California Highway Barrier Aesthetics

This report will familiarize designers with current barrier design options, and encourage appropriate aesthetic considerations to develop visually pleasing context sensitive solutions for highway projects. The development of alternative barriers that are aesthetically pleasing is a continuing process. The Division of Design, Office of State Landscape Architecture, Headquarters Traffic Operations, and Division of Engineering Services, Materials Engineering and Testing Services, Office of Structural Materials will continue to develop technical guidelines and guidance documents for alternative barriers and surface treatments for concrete barriers.

Technical guidelines allow integral color, paint, stain, and subtle textures to be incorporated with concrete barriers placed on highway transportation projects. These guidelines address highway corridor aesthetic issues, and respond to concerns from local communities and agencies for more barrier design alternatives that are context sensitive without compromising safety considerations.

Efforts are continuing to crash test additional aesthetic design solutions to increase the variety of options available for barrier treatments. These tests comply with the National Cooperative Highway Research Program (NCHRP) Report 350 criteria. Crash testing is being performed on various formliner patterns for concrete barriers that mimic stone masonry or provide relief graphics into the surface of the concrete. Patterns and textures with subtle relief, set into the surface of the barrier or limited to the top portion of the barrier, have shown encouraging results and guidelines for their use have been approved. Alternatively, crash test results indicate that some patterns and textures with high relief extending from the base to the top of the barrier may cause excessive passenger compartment deformation to the vehicle. Future use of these high relief surface treatments is doubtful. The technical guidelines for use of textures on concrete barriers will continue to evolve based on crash test results, maintenance and construction issues.

There is additional cost associated with some alternative barriers and surface aesthetic treatments when compared to the Department's standard barriers. Designers should use discretion when selecting alternative designs. Local funding may be required to offset additional costs associated with alternative barrier designs. Barriers are available in several different types and materials providing an opportunity to select the most appropriate barrier for a particular condition. Barrier types and design considerations discussed in this report include:

- Thrie Beam Barrier
- Three-Cable Barrier
- Type 60 Concrete Barrier
 - Approved Concrete Barrier Aesthetics
 - Developing Textures and Patterns
- Timber Guardrail
- Precast Concrete Guardwall
- Stone Masonry Guardwall
- Barriers and Landscaping

The Thrie Beam Barrier and Type 60 Concrete Barrier are available in the Department's Standard Plans and Specifications. The other barrier types will require approval for use until such time they become approved standards. See "Attachment A" for information on the non-standard approval process. For further information on California Highway Barrier Aesthetics and the status of new design alternatives please contact the Office of State Landscape Architecture at (916) 653-3170, Headquarters Traffic Operations at (916) 654-5147, or Materials Testing and Engineering at (916) 227-7000.

Type 60 Concrete Barrier

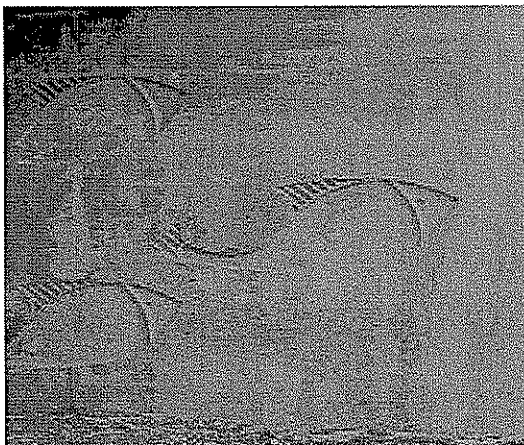
Developing Textures and Patterns

A wide array of design possibilities are being developed and crash tested to allow for textures, patterns, and graphics that enhance the appearance of Type 60 Concrete barriers. Before authorizing textured surface treatments to concrete barriers, the proposed treatments must be tested for safety, and reviewed for constructability and maintainability issues. The Department's Engineering Services Division of Materials Engineering and Testing Services, Office of Structural Materials performs these tests by crashing a vehicle, under controlled conditions, into a section of the textured concrete barrier.

The results of each crash test are analyzed and a determination is made as to whether the textured barrier passes or fails established performance criteria - NCHRP Report 350 criteria, test level 3. From crash test results the Department has developed preliminary technical guidelines for the use of textures on concrete barriers. The Department will continue to perform additional crash tests to further expand these preliminary technical guidelines.



Dry stacked rock design was recently crash tested and received approval for use in California.



Pending approved design guidelines, graphics could become an integral part of concrete barrier design.

The next few pages of this report discuss textures that designers may use to address site specific, context sensitive solutions for concrete barriers. Specific textures will not be approved or disapproved but the depth, protrusions, angle of patterns, etc. will be governed by technical guidelines.

Details of recent test results are contained in the Department Study #F2001T117 "*Interim Report, Crash Testing of Various Textured Barriers.*" Contact Materials Testing and Engineering at (916) 227-7000 for a copy.

Type 60 Concrete Barrier

Developing Textures and Patterns, continued

The Federal Highway Administration (FHWA) has granted approval (December 2002) of the Department's technical guidelines for textures and patterns for use on Type 60 Concrete barriers. Departmental approval is needed for the use of textures and patterns on every project. The following surface textures and patterns have been crash tested:

- Rock cobble pattern above 610 mm of smooth surface barrier. **PASSED CRASH TEST**
- "Mission Arch" pattern. **PASSED CRASH TEST**
- Dry stacked rock pattern. **PASSED CRASH TEST**
- Fractured granite pattern. **PASSED CRASH TEST**
- Rock cobble pattern on the entire face of the barrier. **FAILED CRASH TEST**
- Diagonal flute pattern. **FAILED CRASH TEST**

The preliminary technical guidelines allow:

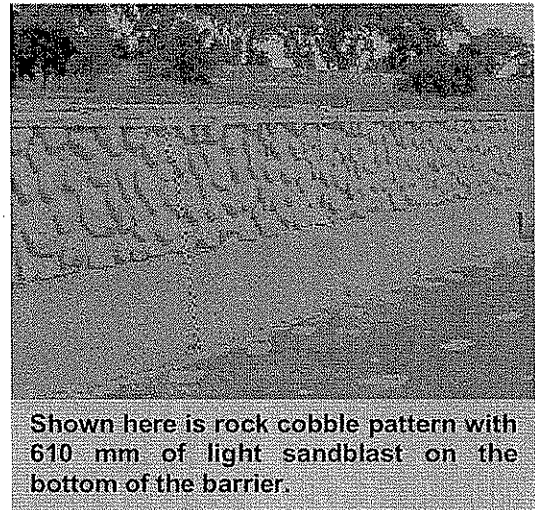
Light to heavy sandblast textures.

Any pattern or texture with a maximum relief of 64 mm or less, located 610 mm or higher above the base of the barrier; the lower 610 mm shall be smooth or a "light to heavy sand blast" texture. The pattern or texture on the upper face of the barrier shall have smooth (rounded or beveled) leading edges to prevent vehicle snagging.

Geometric patterns inset into the face of the barrier 25mm or less. Chamfered or beveled edges to prevent vehicle snagging, especially on the downstream edges. Such patterns shall not feature long upward-climbing edges that could contribute to wheel climb.



This is the mission arch design with beveled edge and light sandblast.



Shown here is rock cobble pattern with 610 mm of light sandblast on the bottom of the barrier.

Advantages

- Aesthetic treatment for context sensitive solutions
- Preserves/protects median planting
- Long life and durability

Disadvantages

- Non-standard approval required
- Standard Plans and Specifications not available
- Increases installation costs
- Increases construction time
- Additional repair work to match textures

Costs (June 2002)

- \$115 to \$150 per meter, depending upon aesthetic treatments and color. The average price of a Concrete Barrier (type 60) is \$91.39 per meter.
- Maintenance cost of aesthetic treatments not known

Precast Concrete Guardwall

This barrier system is being reviewed for approval by the Department's Highway Safety Features New Products Committee for use on California's highway system. This precast concrete guardwall has not yet been used in California due to very high construction costs. This guardrail has no approved terminal design. The end treatment will need crash cushions, must be buried in the embankment, or will require some other approved terminal design.

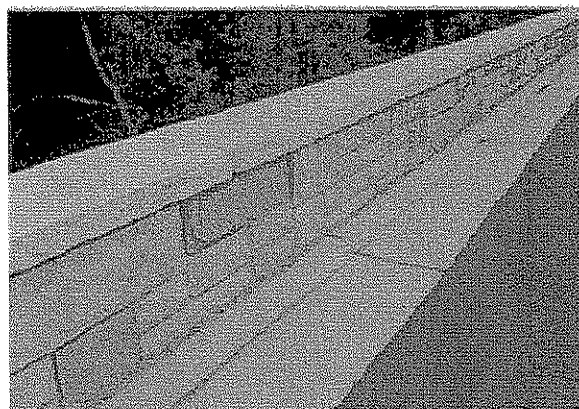
The finish treatment is a simulated stone surface on both sides and ends of the guardwall. The surface of the guardwall is stained to simulate individual stones. The design details include a precast concrete mowing strip. This strip may be placed in medians that will not be paved to the face of the guardwall. To meet federal standards, the Precast Concrete Guardwall must be fabricated in a precast concrete production facility certified by the National Precast Concrete Association.

The Precast Concrete Guardwall has been crash tested and meets the requirements of NCHRP Report 230. Though never crash tested to NCHRP Report 350 test level 3, the FHWA has accepted this guardwall for use on Federal highways. This artificial stone system is approved for design speeds of 100km/h or less. Further information regarding this barrier, such as electronic drawings, specifications and other information, may be found at www.evl.fhwa.dot.gov.



Advantages

- Electronic drawings and specifications are available
- Rural character
- Aesthetic treatment for context sensitive solutions
- Long life and durability



This guardwall is installed on the Federal highway system in the East Coast.

Disadvantages

- Non-standard approval required
- Standard Plans and Specifications not available
- Requires drainage modifications
- Very high installation costs
- Additional roadside maintenance tasks compared to Type 60 Concrete barrier

Costs (February 2002)

- \$740 per meter. Shipping cost to the project site from the manufacturer is not included in this estimate
- Maintenance cost is not known

Stone Masonry Guardwall

The Stone Masonry Guardwall was approved by the Department's Highway Safety Features New Products Committee for use on California's highway system. The Stone Masonry Guardwall has not yet been used in California due to the very high construction cost. The stone fascia, mortared in place, provides a natural appearance and can incorporate local rock to match the surrounding area. The Federal Lands Highway Office must approve any modifications to Federal Lands Highway Standards for the Stone Masonry Guardwall. This guardrail has no approved terminal design. The end treatment will need crash cushions, must be buried in the embankment, or will require some other approved terminal design.

The Stone Masonry Guardwall consists of a concrete core faced and capped with natural stone. The Stone Masonry Guardwall has been crash tested and meets the requirements of NCHRP Report 230 and is accepted by the FHWA for use on the federal highway system. The FHWA has accepted it to meet the requirements of NRCHP Report 350 criteria, test level 3. This barrier system is approved for design speeds of 100 km/h or less.

Specifications define maximum projections to be 38 mm beyond the neat line, 50 mm deep joints, and mortar beds 50 to 75 mm thick. Stone faces with critical dimensions greater than those listed above are not considered crashworthy. A smooth-faced wall with shallower projections, and rake joints and beds is also approved.



Advantages

- Electronic drawings and specifications are available
- Minimal visual impact
- Rural character
- Context sensitive solutions
- Preserves/protects median planting
- Long life and durability



Disadvantages

- Non-standard approval required
- Standard plans and specifications not available
- Requires drainage modifications
- Very high installation costs
- Increased construction time
- Additional roadside maintenance tasks compared to Type 60 Concrete barrier

Costs (February 2002)

- \$830 per meter
- Cost will vary depending upon the type of rock used. Availability of rock and proximity to the project area will be a factor. Labor costs may significantly impact the actual construction cost.
- Maintenance cost not known; likely to be high